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The Basic Requirements and Suggestions for the Acoustic Environment of Classical Singing Teaching Sites

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Abstract: The most important factor that determines the acoustic environment is the reverberation time, the reverberation time of the teaching site is too short will cause the lack of signal reception in the auditory aspect of the teaching staff, the reverberation time is too long will affect the clarity of the sound. Only the right amount of reverberation time can meet the environmental conditions of classical singing teaching, so that the teaching can get twice the result with half the effort. This paper further explores how to create a suitable acoustic environment for classical singing teaching by studying the reverberation time requirements of the acoustic environment required for classical singing, and attempts to make reasonable suggestions for adjusting the reverberation time of the room.

Keywords: Acoustic environment; Classical singing; Large acoustic room; Reverberation time; Singing frequency

1. Requirements for the reverberation time of the acoustic environment required for classical singing

Halls with different purposes have different optimal reverberation times. Generally speaking, the optimal reverberation time of concert halls and theaters is longer than that of lecture halls, and it varies from situation to situation.[1] Popular music requires a strong sense of rhythm and a shorter reverberation time, while the reverberation time of symphony music can be longer. Of course, reverberation is not only an important acoustic characteristic of buildings such as concert halls, theaters, and auditoriums, but it also has a decisive impact on the teaching quality of classical singing teaching. For example, people often sing in the shower. This is because bathrooms are generally small and decorated with ceramic tiles. The walls and floors of the bathroom are easy to reflect sound. The sound reverberation in the living room is greater than that of ordinary living rooms, and the reverberation effect will make your voice sound fuller, so you will feel that the songs you sing are particularly pleasant. Another example is that when we sing in a flat wilderness, there is no echo at all, and it sounds too dry and dry; while singing in a valley, there will be echoes, resulting in the feeling of "sound transmission in the empty valley".[2] This is because the sound from the throat when singing is not the same as the sound heard by the ears: the sound from the throat is the sound wave formed by disturbing the air, and the sound heard is that the sound wave arrives directly or indirectly. Disturbances transmitted to the ear after reflection mixing.

From the above examples, it is not difficult to see the importance of reverberation for classical singing. When we design classical singing teaching venues, if the design produces many echoes, it must be a failure. But if there is no reflection at all, the walls, ceiling and floor are all made of sound-absorbing materials, and the sound will not be pleasant. So it is necessary to have a certain degree of reverberation. According to the research, it is found that the reverberation time of a good classical singing teaching place to the intermediate frequency is about 1.68 seconds.[3]

2. The choice of a good acoustic environment - a large room in the acoustic sense

2.1 What is a large room in the acoustic sense

In a room used in the sound signal frequency does not meet the conditions for the generation of diffuse sound field or reverberant sound field, from the acoustic point of view should be regarded as a small room in the acoustic sense. If the fre-

quency of the sound used in the room satisfies the generation conditions of a diffuse sound field or a reverberant sound field, it should be regarded as a large room in the acoustic sense from an acoustic point of view.[4] The propagation and distribution of sound waves in a room first depends on whether the room is a large room in the acoustic sense or a small room in the acoustic sense. The way sound propagates in these two rooms is different. If the length of the sound wave wavelength is much smaller than the size of the room, the sound wave will only be refracted and reflected in the room. On this scale, the sound wave propagates along a straight line, which can only be studied by the method of geometrical acoustics. A large room in the acoustic sense can form a reverberant sound field or a diffuse sound field. In a large acoustic room, when a sound source sends out a signal, in addition to receiving the direct sound, the receiver will also receive reflected sound from various places in the room, that is, the receiver can receive the sound source from all directions. The transmitted sound energy, and the sound energy distribution in each direction is relatively uniform. In a large acoustic room, the length of the sound wave is much smaller than the size of the room, and the sound wave will propagate along a straight line, and the reflection of the sound wave in the room can make the sound energy of the room evenly distributed, forming a reverberant sound field. On the contrary, it is difficult for a small room in the acoustic sense to form a reverberation sound field. If the size of the room is greater than or equal to the length of the sound wave generated by the sound source, the sound wave will not be reflected and propagated in a straight line, and the sound energy distribution will not be uniform. Yes, each place in this room has different sound energy distribution, so it is impossible to form reverberation or diffuse sound field. A small room in the acoustic sense cannot be analyzed and calculated in the way of geometric acoustics, but must be analyzed and calculated with wave acoustics. Wave acoustics mainly studies interference and diffraction. So how to define the size of the room in the acoustic sense? It is mainly different from the wavelength of the sound used in the room. If the wavelength of the sound is greater than or equal to the size of the room, it belongs to a small room in the acoustic sense. If the wavelength of this sound is smaller than the size of the room, it is an acoustically large room. According to the formula $c=\lambda f$ We can know that the wavelength is equal to the speed of sound propagation and the frequency of sound. The propagation of sound in the air is about 340 meters per second. By calculation, we can get that when the frequency of the sound is 100 Hz, the wavelength of the sound is 3.4 meters. When the sound propagates in a room larger than 3.4 meters, it is An acoustically large room is formed, resulting in a reverberant sound field.

2.2 The basic requirements of the acoustic environment for classical singing to the acoustic large room

In classical singing, the voices are bass, baritone, tenor, alto, mezzo-soprano and soprano. The frequency of the sound produced by the baritone is 82 to 392 Hz, the baritone 123 to 493 Hz, the tenor 164 to 698 Hz, the bass 82 to 392 Hz, the bass 123 to 493 Hz, and the soprano 220 to 1.1 KHz. the frequency of the sound produced by the baritone is the smallest, and its sound wavelength is the longest. Among them, the frequency of the sound produced by the bass is the smallest, and its sound wavelength is the longest. We take the voice of the bass as a reference. When the voice of the bass can produce reverberation in a room, the singing of other voices must be able to produce reverberation in this room. The lowest vocal frequency for a bass is 82Hz, by calculating we get 82HzThe wavelength of sound is 4.15rice. Therefore, when the length and width of the room can exceed 4.15 meters may allow all the sound parts in this room to produce a reverberant sound field. If the room is too small and the dimensions are smaller than the wavelength, it will not produce a reverberant effect. By choosing a room larger than 4.15 meters as a place to teach classical singing, the sound energy can be better distributed evenly, and such an acoustically large room can satisfy the mutual cooperation between students and teachers.

3. Advice on how to adjust the room reverberation time

To control the reverberation time, we must fully understand several basic factors that affect the length of the reverberation time in the basic Sabine reverberation formula. The Sabine reverberation formula is $RT60=0.161V/(S\times a)$, where RT60 is the reverberation time, V is the room volume, S is the total surface area of the room wall, and a is the average sound absorption coefficient of the room surface. Therefore, when the total surface area of the room is a fixed constant, then the key part that affects the length of reverberation time is the total amount of sound absorption on the surface of the room. We can control the reverberation time of the room by the following two ways, absorption treatment and diffusion treatment.

When it is impossible to change the reverberation time from the perspective of room size, it is necessary to consider the use of acoustic materials to change the sound absorption of the room surface. Real-time measurement of its reverberation time. If the reverberation time is found to be too long, various sound-absorbing materials can be used to cover the surface of the room to increase the overall sound absorption of the room and reduce the reverberation time. There are many kinds of sound-

absorbing materials, which have different sound-absorbing properties for sounds in different frequency bands. When choosing, you can't choose blindly. You must carry out targeted control according to the characteristics of each sound-absorbing material and the characteristics of room acoustics. To control the reverberation time, in addition to using sound-absorbing materials to reduce the length of the reverberation time, reflection and diffusion materials can also be used to increase the length of the reverberation time. Since any material has certain sound-absorbing characteristics, the same diffusing material can effectively diffuse sound, and at the same time achieving a good reverberation time.

In principle, the diffusion of sound waves in the room should be more than absorption, the purpose is to make the resonance intensity lower, to prevent the excessive use of sound-absorbing materials, so as to avoid the reverberation time of the room is too short, resulting in a dry and unrounded sound. Walls can be evenly and appropriately set up some sound absorption and diffusion, for example, a thick wool blanket is an excellent sound-absorbing object, and a wooden doorless bookcase is a good sound diffuser, which is used to adjust the low frequency and has a good effect. In addition, tables, chairs, sofas and other furniture can adjust the sound transmission and can be used for acoustic treatment. The most ideal acoustic treatment is to stick a proper diffuser on the side wall, but it is expensive and affects the appearance. If the sound is found to be too dry, the carpet should be removed first. A sound-absorbing block made of glass fiber or a cloth cushion is placed in the corner of the room for final adjustment of the reverberation time.

4. In conclusion

The main factor that determines the acoustic environment of classical singing is the reverberation time of the room. The premise of producing a reasonable reverberation time must meet the acoustic large room, and a room with a width greater than 4.15 meters is chosen as the teaching site of classical singing to produce a reasonable reverberation time. For a reasonable reverberation time requirements are best close to 1.68 seconds, such as reverberation time is too long can be based on the construction of the room to increase some acoustic materials, such as reverberation time is too short can be arranged some diffusion materials to extend the reverberation time.

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